Variable View Factor Two-Phase Radiator, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

NASA's Space Technology Mission Directorate (STMD) is investigating technologies for thermal control systems (TCS) in human spaceflight vehicles, such as variable geometry spacecraft radiator. The TCS in crewed vehicles must maintain a relatively constant environment temperature for a wide range of external thermal environments (low earth orbit, trans-planetary coast, and planetary surface operations). The sink temperature may vary from approximately 70 K to 230 K.

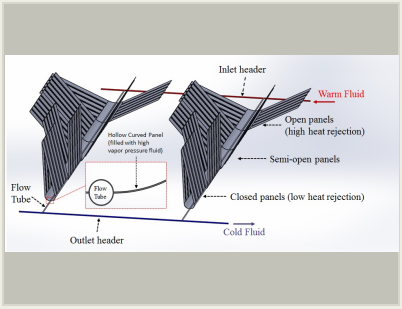
Recent researches investigated and presented potential of heat rejection capability from the morphing composite / shape memory alloys (SMA) radiator. The SMA radiator employs such temperature dependent SMA materials to passively morph the radiator shape and thus adjust the rate of heat rejection to a wide range of vehicle requirements. Nonetheless, utilizing SMA materials faces many disadvantages, including low actuation frequency, sensitivity of material properties in fabrication, residual stress's developed in thin films, and nonlinearity of actuation force.

Advanced Cooling Technologies, Inc. (ACT) proposes to develop a novel vapor-pressure-driven variable view factor radiator as a thermal control system component for spacecraft. Similar to SMA radiator mechanism, the radiator folds into a tear drop shape to minimize the view factor when cold, and opens up to maximize the view factor when heated. However, the proposed device instead utilizes vapor pressure inside a hollow curved panel to change the shape of the radiator. In Phase I, a proof-of-concept two-phase vapor pressure driven morphing radiator prototype will be fabricated and tested. Test results will be used to validate a thermo-structural model, which will be employed to design the full-scale prototype.

Anticipated Benefits

Manned missions and satellites both require radiators with a large turndown ratio, to enable them to maintain maintain temperatures in an acceptable range, with large changes in power and heat sink conditions. The proposed vapor pressure driven variable view factor radiator provides a simple, passive, low-cost method to adjust to changing thermal conditions. The program will demonstrate the feasibility of modeling, designing, optimizing and manufacturing of such an adaptive radiator.

The variable view factor radiator developed by this program can be used for both military and commercial satellites that experience large variations in power or the heat sink. Furthermore, the device can be easily designed to be used as a thermal control component for other satellite and terrestrial applications: stepper motors for solar flaps, as well as variable geometry chevrons and slat-cove fillers onboard transport aircraft, and torque tubes for twisting aircraft wings.



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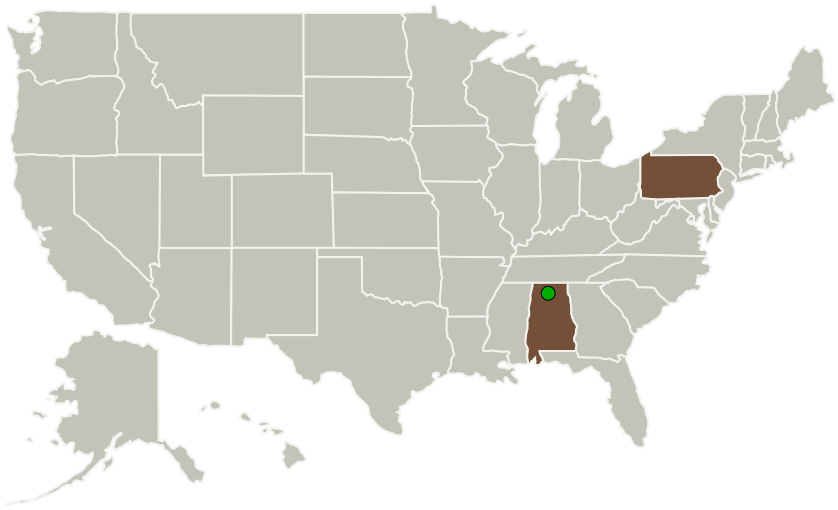
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Advanced Cooling Technologies, Inc.	Lead Organization	Industry	Lancaster, Pennsylvania
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Pennsylvania

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141359)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Advanced Cooling Technologies, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

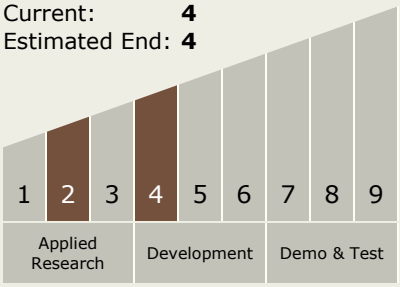
Carlos Torrez

Principal Investigator:

Srujan Rokkam

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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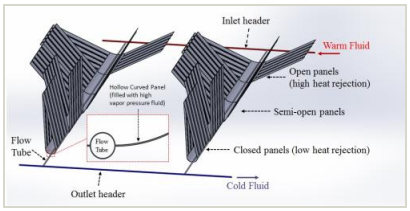
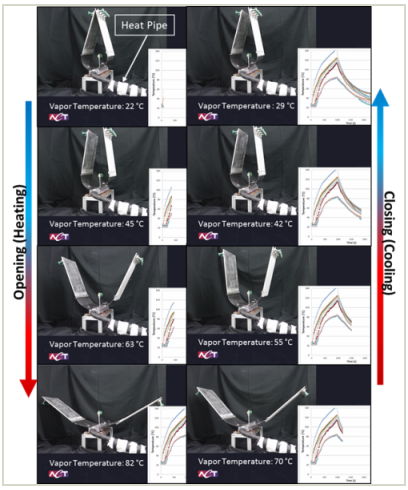
Images



Briefing Chart Image
Variable View Factor Two-Phase Radiator, Phase I
(https://techport.nasa.gov/image/133798)



Final Summary Chart Image
Variable View Factor Two-Phase Radiator, Phase I
(https://techport.nasa.gov/image/130552)

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.2 Thermal Control Components and Systems
    - TX14.2.3 Heat Rejection and Storage

Target Destinations

The Moon, Earth, Others Inside the Solar System